SAND80-0853C

Preprint
Proceedings of 15th Intersociety
Energy Conversion Engineering Conf.
Aug. 17-22, 1980 - Seattle, WA

INTERMEDIATE LOAD-CENTER PHOTOVOLTAIC APPLICATION EXPERIMENTS*

CONF-800806--11

E. L. Burgess
Sandia National Laboratories
Albuquerque, NM 87185

Abstract

A total of nine intermediate load-center photovoltaic systems were carried into the construction phase this year. These nine systems range in size from 20 to 225 kW_p electrical output and total almost 1 MW_p. They are being installed in a diverse set of applications and locations and represent the bulk of the photovoltaic initial system evaluation experiments (ISEE) for the intermediate load-center sector. Each of these experiments are briefly described and the status of the construction phase is given for each project.

Introduction

In November 1977, the U. S. Department of Energy issued a Program Research and Development Announcement (PRDA) for the design, installation, and operation of photovoltaic (PV) system experiments in on-site applications using concentrator arrays. This PRDA was followed in March 1978 with one for similar system experiments but utilizing flat plate arrays. Both of these programs called for a phased effort in which a number of conceptual designs would be selected for detailed design and then a smaller number of the detailed designs would be selected for installation and operation. Twenty-nine conceptual designs were selected for detailed designs (17 concentrator arrays and 12 flat plate arrays). From these detailed designs a total of five concentrator array systems and 4 flat plate array systems were selected for installation and operation. These nine systems are now in the installation phase. After installation is complete the PV systems will be operated for a minimum of two years to evaluate the effectiveness of the PV systems in the particular on-site applications. The purpose of this paper is to give a status report on the system installations.

*This work was supported by the U. S. Department of Energy (DOE), Division of Photovoltaic Energy Systems.

System Descriptions

Table I lists the nine experiment locations, sizes, and applications. Below, each system is briefly described. For a more detailed system description the reader is referred to Reference 1.

Acurex Corporation

The Acurex Corporation of Mountain View, CA is installing a 60 kW_p system to supply electrical energy to the Wilcox Memorial Hospital in Kauai, HI. This system utilizes parabolic trough concentrator arrays which are oriented north-south and track the sun in the east-west direction. The water coolant for the PV cells is heated to a maximum temperature of 88°C and the collected thermal energy is used to provide domestic hot water for the hospital. Figure 1 is a block diagram of the electrical and thermal system. Acurex manufactures the parabolic trough collectors and either Applied Solar Energy Corporation (ASEC) or Solarex will supply the PV cell assemblies. This project is highly endorsed by the State of Hawaii which is providing significant cost-sharing with the DOE.

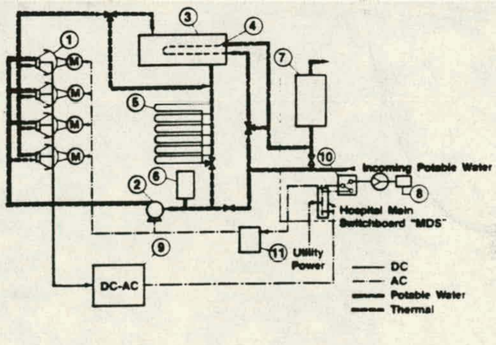

Fig. 1 - Electrical and thermal system block diagram for the Wilcox Memorial Hospital.

DISCLAIMER

Table I - List of prime contractors, system size, location, and application for all nine application experiments.

- **ACUREX - 60 kW CONCENTRATOR FOR KAUAI, HI HOSPITAL**
- **APS - 225 kW CONCENTRATOR FOR PHOENIX, AZ AIRPORT**
- **BDM - 50 kW CONCENTRATOR FOR ALBUQERQUE, NM OFFICE BUILDING**
- **E-SYSTEMS - 27 kW CONCENTRATOR FOR DALLAS-FT. WORTH, TX AIRPORT**
- **GE - 110 kW CONCENTRATOR FOR SEA WORLD, ORLANDO, FL**
- **LEA CO. ELECT. - 150 kW FLAT PLATE FOR LOVINGTON, NM SHOPPING CENTER**
- **NMSU - 20 kW FLAT PLATE FOR EL PASO, TX UPS**
- **SAI - 150 kW FLAT PLATE FOR OKLAHOMA CITY, OK SCIENCE & ART CENTER**
- **SOLAR POWER - 150 kW FLAT PLATE FOR BEVERLY, MA HIGH SCHOOL**

Arizona Public Service Company

The largest project in this program is being installed by the Arizona Public Service Company at the Phoenix, AZ Airport. The system utilizes 225 kW_p of a new point-focusing Fresnel lens array design by Motorola's Government Electronics Division. Half the PV cell assemblies will be supplied by ASEC and the remaining half by Motorola's Semiconductor Products Division. The array is a two-axis tracking type and is passively cooled. The electrical energy is supplied to a new terminal building at the airport. Figure 2 is a block diagram of the electrical system.

BDM Corporation

The BDM Corporation is installing a roof-mounted concentrator system on their new office building in Albuquerque, NM. The parabolic trough concentrator provides both electrical and thermal energy for the building. The Solar Kinetics Incorporated collectors will produce 43°C water to heat the building and 47 kW_p of electrical power when combined with the ASEC supplied PV cell assemblies. In the summer the thermal energy is dumped with a cooling tower. The one-axis tracking troughs are oriented north-south. Figure 3 shows an artist's rendering of the completed system on the BDM building.

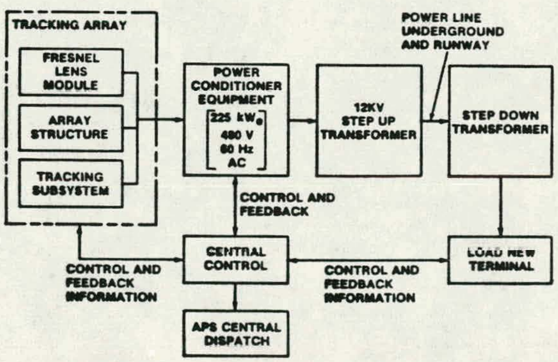

Fig. 2 - Electrical system block diagram for the Phoenix Airport.

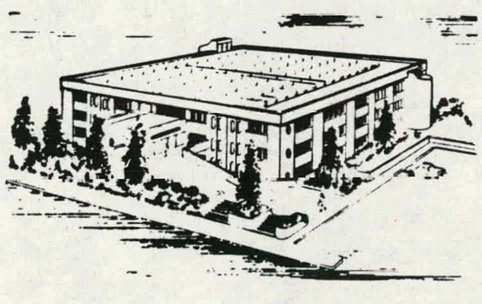

Fig. 3 - Artist's rendering of the BDM office building with PV system installed.

E-Systems Incorporated

The physical plant at the Dallas-Ft. Worth, TX Airport is the site for the 27 kW_p system being installed by the Energy Technology Center of E-Systems Incorporated. This concentrator system is also roof-mounted. It utilizes a linear Fresnel lens array manufactured by E-Systems with ASEC supplied PV cell assemblies. This system exhibits the highest overall conversion efficiency of solar energy to useful energy of any of the nine projects. On an annual basis, 8.43% of the sunlight is converted to net electrical energy and supplied to a 24-hour per day physical plant lighting load. Almost 50% (49.3%) of the sunlight is converted to thermal energy which is used to pre-heat boiler feedwater for the physical plant steam generator. Figure 4 shows a sketch of the 1-1/2 axis tracking array which accomplishes this 57.7% sunlight conversion.

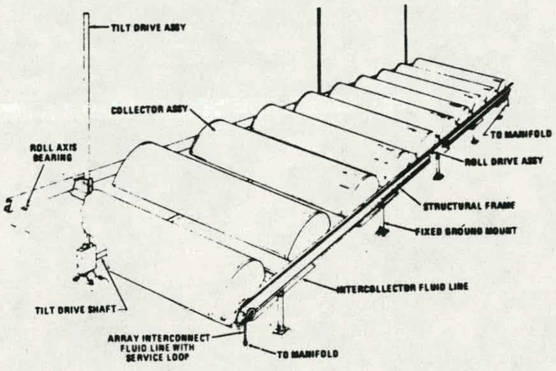

Fig. 4 - E-System's linear Fresnel lens PV concentrator array for the Dallas-Ft. Worth Airport installation.

General Electric

General Electric will install 110 kW_p of their 2-axis tracking parabolic trough array design at Sea World in Orlando, FL. The electrical energy will power a new shark exhibit and thermal energy collected from cooling the PV cells will operate an absorption cooler which will supply some of the chilled water used to condition the water in the marine exhibits. PV cells are being supplied by Solarex. Figure 5 shows a layout for the baseline design of 330 kW_p (9 arrays). The 110 kW_p (3 arrays) option was chosen for the project to conserve project funds.

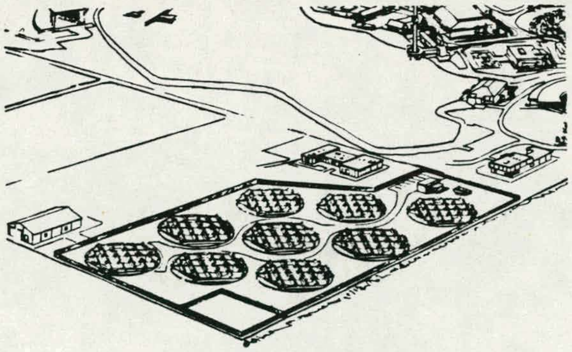

Fig. 5 - Baseline design PV system layout for Seaworld.

Lea County Electric Cooperative, Incorporated

A shopping center in Lovington, NM will serve as the load for a 150 kW_p flat plate system being installed by the Lea County Electric Cooperative, Incorporated. The system is actually three subsystems of 50 kW_p, each operating in parallel with each other and with the Lea County Electric grid. Such a modular approach is perhaps a forerunner of low cost designs of the future. Solar Power Corporation (SPC) is supplying the flat plate PV modules. Figure 6 is the artist's concept of the completed system.

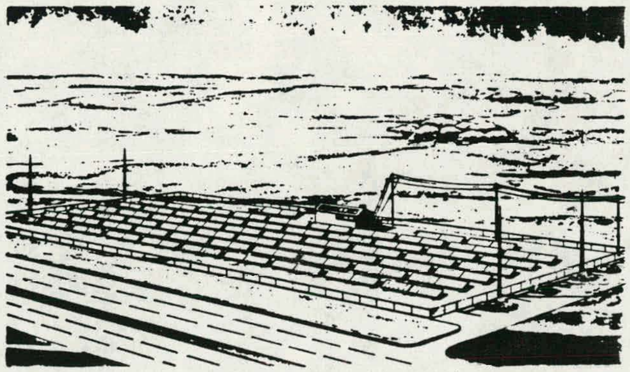

Fig. 6 - Lovington, NM shopping center flat plate array.

New Mexico State University

The New Mexico Solar Energy Institute of the New Mexico State University is prime contractor for the smallest system to be installed as a part of this program. Seventeen and one-half kilowatts peak of SPC flat panels will be installed at the El Paso Electric's Newman Power Station near El Paso, TX. The systme is the only DC system and supplies power to the uninterruptible power supply (UPS) which powers the plant control computer. Figure 7 is a simplified diagram of the UPS system. The array will be connected to the 134 vdc output bus of one of the battery chargers.

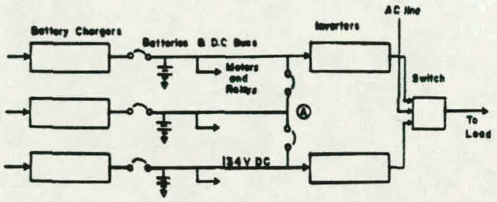

Fig. 7 - UPS block diagram of El Paso Electric's Newman Power Station.

Science Applications, Incorporated

A reflector augmented flat plate system will be installed at the Oklahoma Center for Science and Art (OCSA) in Oklahoma City, OK by Science Applications, Incorporated (SAI). Solarex will supply 110 kW_p of semicrystalline silicon flat panels and the peak system output rating will be increased to 150 kW_p with the reflector augmentation. OCSA is cost-sharing 10% of the project cost with the DOE. The array is roof-mounted; Figure 8 shows the OCSA building and array in artist's rendering.

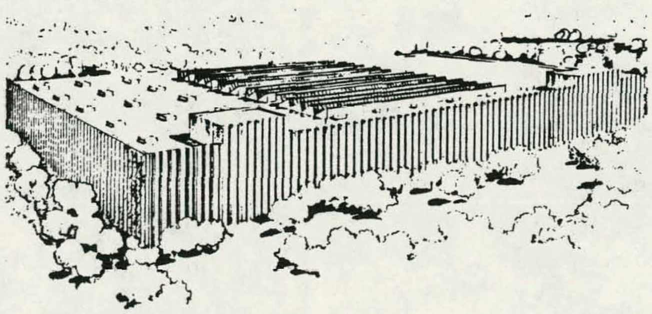

Fig. 8 - Artist's rendering of Oklahoma Center for Science and Art Building with PV system installed.

Solar Power Corporation

A companion system to the Lea County project is being installed by Solar Power Corporation at the Beverly High School in Beverly, MA. The system uses the same modular design as the Lea County project and incorporates three 50 kW_p subsystems. The power is fed to the high school and on weekends excess power is fed back into the grid and New England Electric credits the school for this feedback. Figure 9 is the artist's concept of the completed Beverly installation.

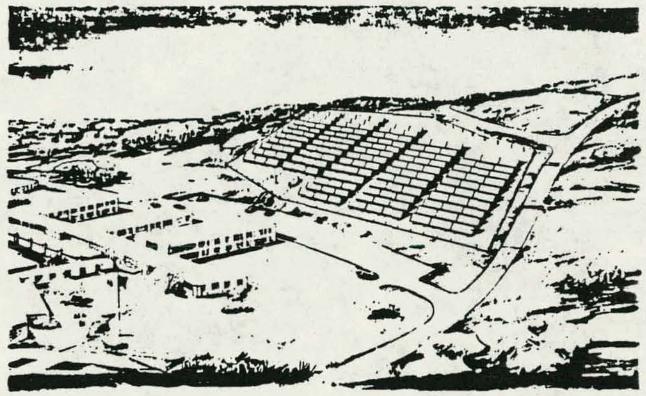

Fig. 9 - Beverly High School PV array.

Milestones and Status

Figure 10 is a summary milestone chart for all nine projects. The key milestones shown on this chart are: 1) project start, 2) critical project review (CPR), 3) start site preparation, 4) system completed, and 5) project dedication. The status is indicated as of June 1, 1980. The CPR is analogous to a critical design review plus an updated cost estimate is presented. Also, in the case of the concentrator projects, prototype arrays have to have passed an environmental test program. The flat plate programs accomplished this hardware qualification during the design phase with the exception of the SAI module; some additional hail testing is required on that module.

Initial system operation is planned in late CY80 for the BDM, NM State University, Lea County, and Solar Power projects. All other projects are scheduled for completion in CY81. The longer time to CPR for the concentrator projects is due to

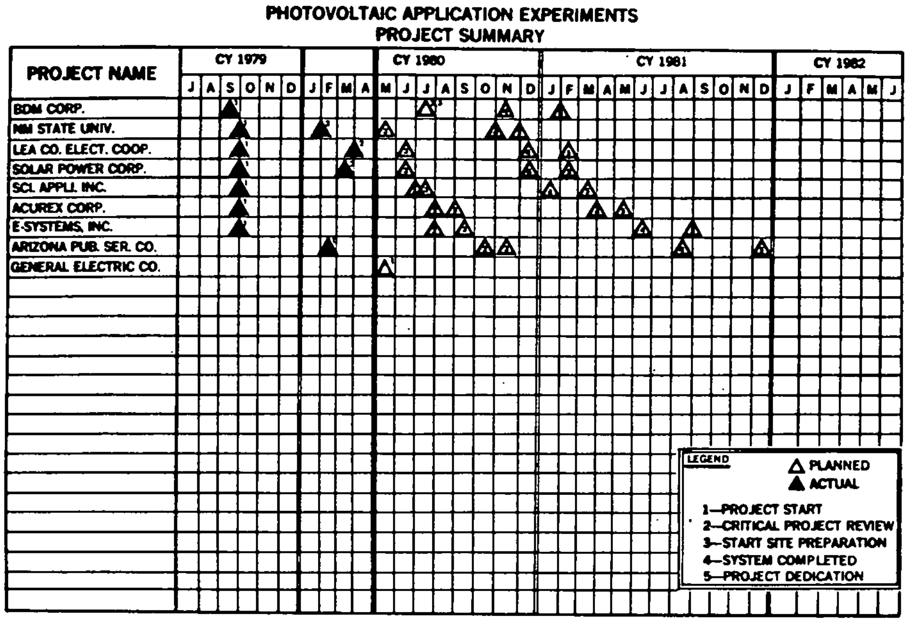

Fig. 10 - Major milestone schedule for all nine application experiments.

the hardware testing requirement. At the time of this publication the General Electric project had just been initiated and schedule information was not available. For the most part the projects are on schedule.

Reference

1. E. L. Burgess and E. A. Walker, "Summary of Photovoltaic Application Experiments Designs", U. S. DOE Report ALO-71, October 1979.